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COMPARATIVE EVALUATION OF INCREASED RATES OF SEKATOR OD ON THE EFFICACY AND GROWTH TRAITS IN WINTER WHEAT

Berkan SHABAN, Nesho NESHEV, Krasimira UZUNOVA, Mariyan YANEV, Anyo MITKOV

Agricultural University of Plovdiv, 12 Mendeleev Blvd, Plovdiv, Bulgaria

Corresponding author email: n_neshev85@abv.bg

Abstract

In the winter wheat vegetation period of 2019/2020 a field experiment with Sekator OD (100 g/l amidosulphuron + 25 g/l iodosulfuron + 250 g/l mefenpyr-diethyl) was conducted. The trial was situated on the experimental field of the Agricultural University of Plovdiv, Bulgaria. Variants of the trial were: 1. Untreated control; 2. Sekator OD - 0.10 l ha^{-1}; 3. Sekator OD - 0.15 l ha^{-1} and 4. Sekator OD - 0.20 l ha^{-1}. The herbicide application was performed in tillering stage (BBCH 21-29) in spring. For the study's purposes, the "Avenue" variety was grown. As well as the efficacy and the selectivity of the herbicide product, several quantitative and qualitative indicators were evaluated. The highest efficacy against the existing broadleaf weeds for the rate of 0.20 l ha^{-1} was recorded. There were no visual phytotoxic symptoms for the crop for any of the evaluated rates. By using the statistical criterion of Student Test, a positive and significant increase in the values of stem height at the rate of 0.10 l ha^{-1} and the number of ears at the rate of 0.20 l ha^{-1} were found.

Key words: *Triticum aestivum L., efficacy, biometry, herbicide, yield.*

INTRODUCTION

The high weed infestation in winter wheat (*Triticum aestivum* L.) can decrease the yields up to 70% (Tonev et al., 2011; Tonev et al., 2007; Bekelle, 2004). The effective weed management in winter field crops is a main part of successful agricultural production (Brooke and McMaster, 2016). Weed control in winter wheat is performed by applications of different protective and agricultural measures, as well as herbicide applications in dependence of the dominating weeds (Markovic et al., 2005).

Depending on the crop management and the meteorological conditions, the different weeds can be in different density and can form different weed associations (Dimitrov et al., 2016).

The choices of relevant herbicide product, optimal application period, as well as phenological stage of treatment are one of the most important points of the crop management (Abbas et al., 2009; Khalil et al., 2008; Sherawat and Ahmat, 2005). In the modern agriculture the weed control is mainly performed by the chemical method. A number of authors study the selectivity and efficacy of different herbicides in crops (Marinov-Serafimov and Golubinova, 2015; Rankova and Tityanov, 2015; Hristova, 2007; Atanasova, 2002). Most of the herbicide products control only a specific group of weeds, and for assuring wide spectrum or weed control it is recommended to use herbicide combinations (Chaudhry et al., 2008; Bostrom and Fogelfors, 2002).

The aim of our study is to evaluate the efficacy of increasing rates of the herbicide product Sekator OD and its influence on some growth parameters of winter wheat.

MATERIALS AND METHODS

The experiment was situated in the experimental field of the Base for Training and Implementation of the Agricultural University of Plovdiv, Bulgaria. The trial was conducted by the randomized block design in 3 replications. The size of the experimental plot was 10 m². The trial included the following treatments: 1. Untreated control; 2. Sekator OD - 1.0 l ha^{-1}; 3. Sekator OD - 1.5 l ha^{-1} and 4. Sekator OD - 2.0 l ha^{-1}.

For evaluating of the efficacy, the 10-score scale of EWRS (European Weed research Society) was used. The herbicide application was accomplished in BBCH 21-29 (tillering stage in spring). In the study, the "Avenue" variety was grown.

On the whole experimental field combined fertilization with 250 kg ha^{-1} with N:P:K (15:15:15), followed by deep ploughing on 25 cm of depth was done. Before sowing of the crop, disk harrowing, two harrowings, as well as spring dressing with 250 kg ha^{-1} NH_4NO_3 was also applied.

The processing of the initial data was done with the statistical package of SPSS 19 program and the comparisons were made once with the control treatment and the second time with each variant with each in order to determine more precisely the influence of the rate of the herbicide product on the change of the values of the studied traits of winter wheat).

With the help of the Student's Test criteria (t) the levels of reliability of the differences between the treatments at calculated probability 5%, 1% and 0.1%. The groups to which the individual variants are included are defined, and the control is always in group IV.

The parameters evaluated: stem height (cm), ear length (cm), ear number, number of grains per ear, grain weight per ear, absolute seed mass, as well as grain yield. The data for the grain yield were processed by Duncan's multiple range test ($p<0.05$).

RESULTS AND DISCUSSIONS

The natural weed infestation on the experimental field was presented by *Sinapis arvensis* L., *Anthemis arvensis* L., *Papaver rhoeas* L. and *Fumaria officinalis* L.

On Table 1 is the obtained data for the efficacy of the studied herbicide product against *S. arvensis*.

Table 1. Efficacy of Sekator OD against *S. arvensis*, %

Treatments/days after application	14th	28th	56th
1. Untreated control	-	-	-
2. Sekator OD - 0.10 l ha^{-1}	85	95	100
3. Sekator OD - 0.15 l ha^{-1}	90	95	100
4. Sekator OD - 0.20 l ha^{-1}	95	100	100

The efficacy of the Sekator OD is excellent for all evaluated rates of the herbicide product. On the last reporting date it is 100% independently the application rate of Sekator OD. These findings correspond with the results of previous our study where 100% efficacy against this weed on the 56th day after treatment was recorded (Mitkov et al., 2017)

The efficacy of Sekator OD against *A. arvensis* is presented on Table 2. The efficacy of the herbicide was also excellent for all evaluated rates against this weed. The efficacy was lower 14 days against the weed and varied between 60-70%. On the last reporting date the efficacy was 100% for the rates of Sekator OD 0.15 and 0.20 l ha^{-1}. The dose of 0.10 l ha^{-1} was 90%. Several researchers have found that *A. arvensis* can be controlled by amidosulfuron + iodosulfuron (Secator 6.25 WG; Sekator and Sekator Progress) (Vilau et al., 2010; Soroka and Soroka, 2003; Adamczewski and Miklaszewska, 2001).

Table 2. Efficacy of Sekator OD against *A. arvensis*, %

Treatments/days after application	14th	28th	56th
1. Untreated control	-	-	-
2. Sekator OD - 0.10 l ha^{-1}	60	80	90
3. Sekator OD - 0.15 l ha^{-1}	65	85	100
4. Sekator OD - 0.20 l ha^{-1}	70	85	100

The efficacy of Sekator OD against *P. rhoeas* is on Table 3. It was found that the lowest rate of 0.10 l ha^{-1} cannot assure sufficient control against this widely spread weed species. On the 14th day after treatment, the efficacy of Sekator OD - 0.10 l ha^{-1} was 35% only. It increased up to 50% on the second evaluation date and reached 65% only on the 56th day after application.

Table 3. Efficacy of Sekator OD against *P. rhoeas*, %

Treatments/days after application	14th	28th	56th
1. Untreated control	-	-	-
2. Sekator OD - 0.10 l ha^{-1}	35	50	65
3. Sekator OD - 0.15 l ha^{-1}	75	85	95
4. Sekator OD - 0.20 l ha^{-1}	85	95	100

In our previous study, the efficacy of the examined rate of Sekator OD (0.12 l ha^{-1}) did not fully control *P. rhoeas*. The obtained efficacy on the 56th day after treatments was 80% (Mitkov et al., 2018). In the present trial, the rates of 0.15 and 0.20 l ha^{-1} for Sekator OD assured excellent efficacy.

The efficacy of Sekator OD against *F. officinalis* is presented on Table 4. According

to Montazeri et al. (2005) *F. officinalis* was relatively tolerant to all evaluated herbicides.

Table 4. Efficacy of Sekator OD against *F. officinalis*, %

Treatments / days after application	14th	28th	56th
1. Untreated control	-	-	-
2. Sekator OD - 0.10 l ha^{-1}	20	25	25
3. Sekator OD - 0.15 l ha^{-1}	25	35	40
4. Sekator OD - 0.20 l ha^{-1}	35	40	45

In our study the efficacy results were not sufficient for any of the evaluated herbicide rates. The efficacy against *F. officinalis* varied from 25 to 45% with increasing of the Sekator OD's doses.

The data for the growth parameters and its statistical analyses is on Table 5.

The meanings of t are as follows: 2.00 ($p<0.05$); 2.66 ($p<0.01$); 3.46 ($p<0.001$).

The indicator stem height is with significantly higher values at the treatment with Sekator OD - 0.10 l ha^{-1} in comparison to the other treatments at $p<0,001$.

Table 5. Data analyses for 5 quantitative parameters of wheat (growth and productive)

Stem height (cm)					
Treatments	Average	Difference	t e	Significance	Group
1	85.00	-	-		IV
2	90.33	5.33	3.94	+ + +	I
3	84.90	-0.10	0.02	ns	IV
4	84.70	-0.30	0.22	ns	IV
Tr. 2 and 3		5.43	4.56	+ + +	I
Tr. 2 and 4		5.63	5.02	+ + +	I
Tr. 3 and 4		0,20	0.22	ns	IV
Ear length (cm)					
Treatments	Average	Difference	t e	Significance	Group
1	9.43	-	-		IV
2	9.14	-0.29	1.88	ns	IV
3	9.15	-0.28	1.38	ns	IV
4	9.66	0.23	1.31	ns	IV
Tr. 2 and 3		-0.01	0.01	ns	IV
Tr. 2 and 4		-0.52	3.56	+ + +	I
Tr. 3 and 4		-0.51	2.79	+ +	II
Ear number					
Treatments	Average	Difference	t e	Significance	Group
1	21.43	-	-		IV
2	21.16	-0.27	0.95	ns	IV
3	21.17	-0.26	0.74	ns	IV
4	22.20	0.77	2.37	ns	IV
Tr. 2 and 3		0.01	0.04	ns	IV
Tr. 2 and 4		1.04	3.85	+ + +	I
Tr. 3 and 4		1.03	3.22	+ +	II
Number of grains per ear					
Treatments	Average	Difference	t e	Significance	Group
1	41.20	-	-		IV
2	47.50	6.30	2.60	+	III
3	53.30	12.1	4.89	+ + +	I
4	54.85	13.6	5.51	+ + +	I
Tr. 2 and 3		5.80	2.15	+	III
Tr. 2 and 4		7.35	2.72	+ +	II
Tr. 3 and 4		1.55	0.57	ns	IV
Grain weight per ear					
Treatments	Average	Difference	t e	Significance	Group
1	122	-	-		IV
2	1.75	0.53	3.94	+++	I
3	2.005	0.78	6.28	+++	I
4	2.05	0.83	7.16	+++	I
Tr. 2 and 3		0.25	2.02	+	III
Tr. 2 and 4		0.30	2.61	+	III
Tr. 3 and 4		0.045	0.48	ns	IV

For two of the studied parameters (ear length and ear number), an overall tendency was found - for all treated variants, non-significant differences with the untreated control was recorded (ns). The effect of the herbicide application and its rate was revealed for treatments 2 and 4 - for the parameter ear length) and for treatment 4 - for the ear number when the comparisons are performed between treated variants (for significance 1% and 0.1%). The higher rates of Sekator OD that showed higher weed control allow winter wheat to develop significantly higher ear number, as well as longer ears.

The results obtained clearly showed the positive effect of the treatment with Sekator OD for the two productive indicators - number of grains per ear and grain weight per ear. At treatments 3 and 4 the significant difference when compared with the untreated control at $p<0,001$ determines the rates of 0.15 и 0.20 l ha^{-1} in the highest group (I).

For the parameter grain weight per ear it was found that the three evaluated rates of Sekator OD showed equal effect when compared to the untreated control at level of significance $p<0,001$.

In the comparison between the studied variants, for the treatments with the rates of Sekator OD of 0.15 and 0.20 l ha^{-1}, a tendency of significant differences according to treatment 2 (Sekator OD - 0.20 l ha^{-1}) at $p<0.01$ and $p<0.05$ was recorded. These findings confirm that application of Sekator OD in higher rates, which removes the concurrence of the crop with the weeds, allows the winter wheat plants to show its productive abilities.

On Table 6 is the obtained data for the absolute seed mass.

Table 6. Percent relation of the absolute seed mass (g)

Treatments/days after application	Mass (g)	%	Sign.
1. Untreated control	29.66	100.0	
2. Sekator OD - 0.10 l ha^{-1}	36.97	124.0	+++
3. Sekator OD - 0.15 l ha^{-1}	37.61	126.8	+++
4. Sekator OD - 0.20 l ha^{-1}	37.45	126.2	+++

The absolute seed mass is very important quality indicator (Mehmood et al., 2014). On one hand, for the treated with Sekator OD variants the difference varied with very low values - from 0.6% to 2.8%. The results recorded proved that with increasing the rate of the studied herbicide product, the absolute seed mass is not significantly influenced. On the other hand, the comparison of the untreated control with all treated variants showed pronounced differences at level of significance $p<0,001$.

The intensive weed infestation can rapidly decrease the grain yield at winter wheat (Mitkov et al., 2018; Mitkov et al., 2017; Walia et al., 2011; Delibaltova et al., 2009; Walia and Singh, 2007; Bekelle, 2004). The choice of proper herbicide, optimal time and rate of application are one of the most important moments for growing winter wheat (Sherawatand, 2005).

The results regarding the yields obtained in our study are on Figure 1.

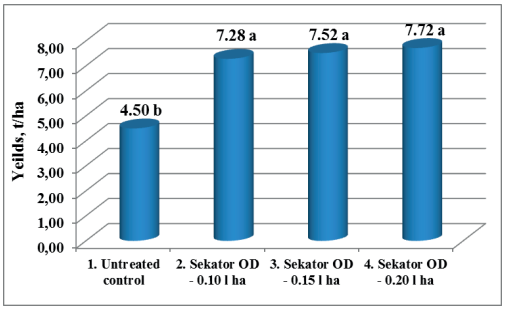

Figure 1. Winter wheat grain yields, t ha^{-1}

Values with different letters are with proved difference according to Duncan's multiple range test ($p < 0.05$)

All studied rates of Sekator OD contributed for obtaining higher yields in comparison with the productivity of the untreated control. The data for the yields of all treated variants are proved differences with the productivity of the untreated control according to Duncan's multiple range test ($p < 0.05$).

CONCLUSIONS

The weeds *Sinapis arvensis* L. and *Anthemis arvensis* L. can be successfully controlled by the lowest examined rate of Sekator OD (0.10 l ha^{-1}). The weed *Papaver rhoeas* L. can be controlled by the increased rates of Sekator OD (0.15 l ha^{-1} and 0.20 l ha^{-1}).

The weed species *Fumaria officinalis* L. cannot be successfully controlled by any of the evaluated rates of Sekator OD.

Visual phytotoxic symptoms for the crop from any of the evaluated Sekator OD doses were not observed.

From the conducted experiment with the winter wheat variety "Avenue" under the conditions of high weed infestation with *Sinapis arvensis* L., *Anthemis arvensis* L., *Papaver rhoeas* L. and *Fumaria officinalis* L. we can summarize that the most significantly influenced productive parameters by the herbicide application are the number of grains per ear and the grain weight per ear, as well as the absolute seed mass, which are one of the most important yield-forming indicators.

The stem height is significantly influenced from the Sekator OD's rate of 0.10 l ha^{-1}, while the number of ears - from the rate of 0.20 l ha^{-1}. All treated with Sekator OD variants had higher grain yields in comparison to the untreated control.

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